AD NUMBER
AD047223
CLASSIFICATION CHANGES
TO: **unclassified**
FROM: **secret**
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; 23 JUN 1954. Other requests shall be referred to Office of Naval Research, Washington, DC.**
AUTHORITY
31 aug 1966, DoDD 5200.9; onr ltr, 13 Sep 1977

AD _____

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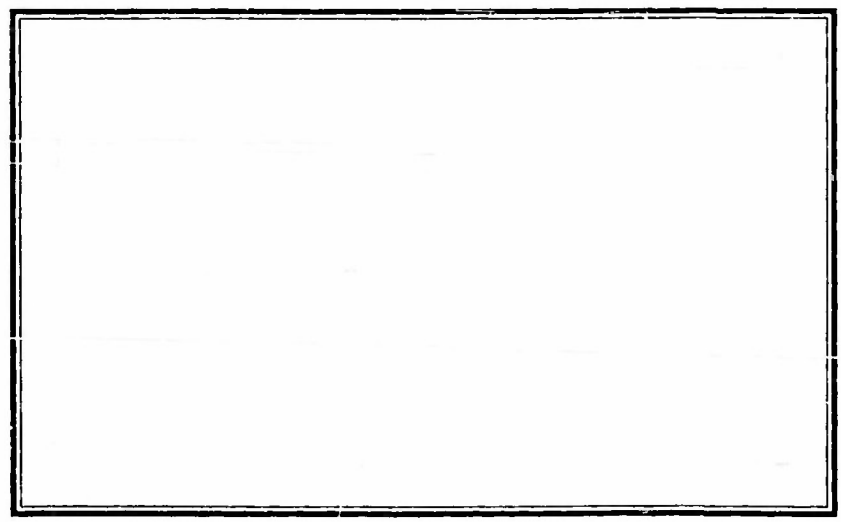

SUPPORTED BY

OFFICE OF NAVAL RESEARCH

CONTRACT NONR--609(02)

Secret

A-5986

SECRET

NR-238-001
Contract Nonr-609(02)

Edwards Street Laboratory
Yale University
New Haven, Connecticut

E. S. L. Study Group Meeting

21, 22, 23 June 1954

ESL:100: Serial 0025

3 August 1954

SECRET

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E.S.L. Study Group Meeting

21, 22, 23 June 1954

INTRODUCTION

During the three-day period 21-23 June 1954 the so-called Study Group of the Edwards Street Laboratory held a conference to discuss the entire concept of coastal and harbor defense, and the problems associated with effecting such defense. The conference was a scientific symposium; prepared papers were presented, followed by spirited discussion from the floor. Meetings were held both morning and afternoon, for three days, with an informal discussion following dinner on 21 June, and a formal meeting the evening of 22 June.

While the following notes of the conference have been edited, it should be kept in mind that the discussion was argumentative (in the most precise connotation of the word), that the viewpoint of the conferees may have changed during the conference, and that individual members may have supported a point for the sake of furthering discussion even though the stated position was not that of the individual.

The essential conclusions reached during the conference are given in the abstract. The announced agenda of the symposium, a list of the attendees at the conference, and a copy of the technical sections of the ESL Contract, Contract Nonr-609(02), with the Office of Naval Research, are enclosed as

Annexes A, B, and C respectively. Annex D is a summary of the conferer-e prepared by the Director of the Contract, L.W. McKeehan.

The notes of the conference were deciphered and edited by the undersigned.

O. Withington
W. Withington

Sheldon D Elliott Jr
S.D. Elliott

M.L. Wiedmann
M.L. Wiedmann

E.C. Pollard
E.C. Pollard

ABSTRACT

1. The subject of the conference is Harbor Protection and Coastal Defense. Two situations are envisioned, limited warfare, such as the Korean engagement, in which "conventional" weapons used in World War II will be employed, and all-out total warfare in which nuclear weapons will be used. Defense concepts in the first case are quite different from those in the second; they are therefore considered separately.

2. In limited warfare, probably away from the shores of the United States, the maintenance of sea lanes and harbors at both ends of the supply line will be of utmost importance to support an expeditionary force.

2.1 Modern mine warfare is at present advantageous for the attacker. The types of triggering mechanisms -- acoustic, magnetic and pressure, combinations of these three, delays and ship counts -- all make the conventional sweeping methods at the least uneconomical, if not entirely incapable of clearing a mined channel with confidence.

2.2 The above is recognized in the Navy, if not by all portions thereof. Since the cards are stacked against the minesweeper, it is undesirable to spend any considerable effort in developing sweeping techniques and equipment which are designed to put up mines with

specialized triggering mechanisms, such as the pressure mine. Any research and development should be directed toward detection and neutralization of any type of mine which the enemy may choose.

3. The most effective defense against any attack begins with intelligence concerning the enemy's plans. In this area scientists, such as those at ESL, may contribute by advising intelligence as to the areas to be explored to the greatest advantage.

4. Immediately after the departure of the enemy from his own bases, long range detection and interception of the attacking vehicles should be put into effect.

4.1 Tremendous expenditure of scientific effort and material procurement has been devoted to the solving of the problem of interception of high flying aircraft. Similar effort is required before detection and interception of low flying aircraft, surface vessels and submarines -- any of which is well-adapted to mining tactics -- can be accomplished with effective attrition of enemy forces well away from the defended shores.

4.2. Several different types of detection are being studied, such as long range low frequency passive listening called LOFAR, low frequency active sonar, LORAD, which

will achieve ranges in the tens of miles in very deep water, but will not be effective over the Atlantic Continental Shelf, and others. Comparative analyses are required to determine the probability of detection by each one of these under different conditions and specific recommendations made as to the location of these devices to achieve the maximum coverage of off-shore waters.

4.3 The probable effectiveness of an offshore patrol by aircraft equipped with the best of ASW instrumentation should be analysed with particular attention to the extent to which such a patrol can usefully supplement other detection methods.

4.4 The technical problems of coordinating all information obtained as from 4.2 and 4.3 should be analysed, particularly with a view to determining how far such coordination can be made automatic, and how possibly conflicting information should be weighted. The administration of an information center which collects all pertinent information, performs the necessary analysis, and controls the interceptors should be studied with care.

5. No long range system of detection and interception promises to be wholly effective and any such system should be backed up by coverage in the region from the harbor entrance to about

50 miles offshore, particularly in the relatively shallow waters of the Atlantic Shelf. To the knowledge of those present at the conference, no effort is presently being put into development of a suitable system for this area.

6. World War II harbor entrance defense equipment is undergoing evaluation at NEL. As soon as the results of this evaluation are known, all harbor entrances should be modernized accordingly.

7. Much more thought could be given to the possibilities of creating sterile channels hostile to mines. In this connection, chemical and biological means of treating harbor water and bottoms to provide greater visibility for mine hunting, or otherwise to influence the environment unfavorably to the attacker might be profitably investigated.

8. In spite of all the precautions taken to detect the enemy before his arrival, some mine layers are likely to penetrate the outer defenses. It is the field of last ditch defense and harbor clearing that ESL has spent the majority of its effort in the last three years. A report on its conclusions as to the method of dealing with air-laid mines will be published this summer. Some further experimental work remains:

8.1 Mine watching by an array of range-only Moving Target indicator radars. Work this summer will be designed

to ascertain the vulnerability of this method to rain and sea clutter.

8.2 Passive listening to the arrival of mines on the bottom. If data confirm the unique signatures of mines dropped from below the surface, mines laid by submarines and surface craft can be located and the methods recommended for subsequently finding and neutralizing air-laid mines can be applied.

8.3 Mine countermeasures vessel. Its design and equipment are now being studied. A prototype should be operated before this study can be said to be complete.

8.4 Navigation of the mine countermeasures vessel and navigation of all ships using a harbor which has been mined requires further study, evaluation of various means, and possibly further experimental work.

9. The power of nuclear weapons is such that the whole harbor and its supporting population becomes the target. The use of small atomic weapons on purely military targets was discussed, and it was believed that retaliation would be immediate and with the most powerful weapons available. Consideration of special defense against limited nuclear attack is not sufficiently different from that against a hydrogen bomb, nor would such warfare continue long enough to justify research in this field.

10. The probable damage resulting from a contaminating nuclear explosion in a harbor area would be so great, and the remaining radiation would continue to be dangerous for such a time, as to make the reoccupation of a harbor thus attacked problematical over a period of months and possibly years.

10.1 Evacuation of key harbor operating personnel is imperative in order that alternate harbors may be employed.

10.2 Since the war would be effectively won by the enemy if the civilian population were not protected, evacuation of the whole population from an area under probable impending attack should be seriously studied.

11. The most probable present method of delivery of an atomic weapon is by high flying aircraft. However, the possibility of delivery of a nuclear time bomb before the beginning of hostilities to the waters of a harbor by innocent-seeming surface craft or sneak submarine should not be ignored. During hostilities a submarine could destroy a harbor from well offshore by launching a guided missile with a nuclear war head. It is not probable that a nuclear mine will be triggered as are conventional mines, since the value of a single ship is small compared to the value of the harbor The logistics of a nuclear war will probably not demand the support of a large overseas land force. However, consideration must be given to the improvement of small harbors to

be used as alternates to the major harbors which may be destroyed.

11.1 An even better alternative, because more flexible, would be the use of beachheads. The sites for these should be studied from the point of view of local land transportation as well as other points of suitability. The development of landing-craft freighters should be undertaken.

12. The best defense against a nuclear attack is, as was discussed in connection with conventional warfare, intelligence, attack on enemy bases, long range detection and interception. No effort should be spared to strengthen ourselves in the hitherto neglected areas of protection from an attack by sea.

ESL Study Group Meeting 21 June

The first day of the meeting was begun by A. Patterson, who introduced E.C. Pollard and set the tone of the meeting.

Mr. Pollard began by stating that the Edwards Street Laboratory is at the cross roads; the Navy's requirements in the present extension of the contract are significantly different from what they have been in the past. We are now being asked to contribute discussion, thought and recommendations, with little accompanying hardware. For the past three years, largely at Beavertail, we have been working on what might have been termed phase I of the program -- experimentation. From this phase we are to produce a report this summer.

However, the coast defense problem is still far from solved. We are still more vulnerable to mining than we were at the beginning of the project, while conventional mine-sweeping is much too expensive for the results to be expected.

We have never discussed the overall problems of mining and mine-countermeasures; this conference is intended to pull the subject together and stimulate discussion of ideas -- the more radical the better.

The problem may be divided into two portions, dealing with (1) sown mines, and (2) immediately destructive nuclear mines.

We are interested in the concept of "defense" against both types,

which is a different concept from that of "cleaning up" now held by the Navy. This latter would be most inadvisable with atomic mines.

What are our opportunities for defense? First, there is the detection of the vehicles which will be leaving mines.

(1) Information gathered by intelligence, to increase the preparation time before the attack. Scientists can undoubtedly contribute to this aspect of defense. The Beacon Hill group examined the matter of intelligence in another connection and produced some valuable ideas. In connection with our task, for example, the existence of certain types of low-flying aircraft in the enemy's stockpile might indicate an interest on his part in air dropping of mines. Or knowledge that he has been indulging in a certain type of reconnaissance would point up the type of attack he was contemplating.

(2) Detection by underwater sound of the approach of enemy submarines. Long range detection allows time for preparation and interception. Whattype of detection gives the greatest promise? Is the answer in the LOFAR being produced by project Jezebel? We should consult Tyrrell of that project and learn all we can. Is there a possible enemy countermeasure to this type of detection, and if so, should shorter range instruments be placed far out in the ocean? What measure of control of friendly traffic is required?

(3) Are there electromagnetic effects produced by approaching enemy craft which can be picked up at low frequencies, and which have so far been ignored?

(4) In the field of radar and visual spotting, have we sufficiently considered the possibility of countermeasures? What is the relative advantage of the MTI radar? We should consider the possibility of sabotaging the splash spotting radar with a number of small surface explosions. Will such sabotage equally confuse the MTI? We should give thought to anti-countermeasures in this field.

(5) How about various types of sneak craft? Have we a suitable defense against a missile like the V-1 which might be very effective against a harbor. How could we cope with submarine-launched large scale torpedoes or propelled mines?

(6) Have we fully considered the requirements for detecting mines laid from surface and subsurface vessels?

(7) We have worked on the detection of mines after laying, which falls into the pattern of the Navy's present thinking.

(8) Can we propose a method of handling a harbor after an attack? If we can produce a plot of locations of laid mines, is it feasible to navigate around the danger areas?

(9) Should we consider sweeping in general with a view to improving it?

(10) What about disarming laid mines? Would 1 kiloton explotion clear a harbor? How about a random search by a Robot, which might be called the Monte Carlo technique?

(11) Could the problem be simplifies by careful selection of harbors with regard to their vulnerability? We must consider the defense of the civilian population as well as of the harbor personnel and facilities. To what extent do we need harbors at all in light of the New Look policy? Are there any radical suggestions concerning harbor design and modification that we could make?

(12) The nuclear weapon poses a new dimension to the problem. Since we are obviously thinking of using it, vide SAC, Strategic Air Command, we must think of the probability of its being used against us.

We should take ourselves very seriously in this conference and imagine ourselves as a body which is going to advise the Navy on high policy matters. We might consider two possible cases:

a. We are going to go to war in Indo-China within a few months. We would have an enormous advantage over the Communists if we could keep our sealanes open.

b. Within two years we will be engaged in an allout war with the Communist world, in which the man who lands the first punch has the advantage.

We would like to propose a program of research as a result of the discussions at this conference.

Pollard concluded and a general discussion followed.

C.T. Lane, who has been a consultant to CIA, believes that they feel intelligence will provide us with quite long advance notice of an attack. Pollard suggested that a conference at a suitable level with CIA would help clear up our thinking on this point, but that we as scientists familiar with the problem might aid in suggesting, for example, the areas in which intelligence might explore.

H. Margenau was interested in finding exactly what can be expected from LOFAR, and further discussion indicated the desirability of studying the NEL work on LORAD and CORSAIR. There is little doubt that the method chosen for long range detection will differ in the Atlantic and the Pacific, largely because of the extent of the Continental Shelf in the former. If long range detection can be made to work satisfactorily, we could then assume that mining by submarine is old fashioned and will not be attempted.

F. Hutchinson threw in the notion that there may be an intermediate type of war -- between the localized version in which WW II weapons are used and the allout type which will employ H-bombs -- in which each side will restrict itself to the employment of "tactical" atomic weapons against purely military installations. An objection to this was brought out: the side that first uses any atomic

weapons of whatever size and with whatever humanitarian application will open itself to all-out retaliation, and the intermediate phase would thus tend to be of very short duration.

The next discussion, on mine sweeping, was opened by L.W. McKeehan.

L.W. McKeehan explained the Navy's present thinking on the subject of mine warfare, and estimated the possibility of its adopting any good ideas which may conflict with its present policy. He stated that the problem of influencing the Navy's policy is not altogether hopeless -- as early as 1951 there had been interest expressed in limiting the areas to be cleaned up, thus saving sweepers. Although sweepers are still being built, certain groups within the Navy realize that sweeping is bankrupt. The sweeper, which simulates a ship (with a somewhat wider path of influence) has only a certain probability of exploding a mine in traversing a dangerous area. The ship also has a certain probability of exploding a mine and itself in the same traverse. With mines equipped with ship counters and delayed arming mechanisms - both standard and tried methods of mining - the probability of either ship or sweeper exploding a mine becomes random, and therefore goes up with the number of ship-sweeper passages. The conclusion can be easily demonstrated that there are not enough sweepers available, and that the investment required for sweeping is thus too high.

The Navy had recognized this a few years ago and was investigating the location of mines with sonar, accompanying this development with the investigation of ahead-thrown weapons for destruction. Unfortunately, as has been amply demonstrated in tests, the probability detection and identification of mines by sonar alone is small with respect to unity so that this method is small with respect to unity so that this method too is "insolvent".

However, to demonstrate that the Navy is not deaf to all new ideas, McKeehan brought out the agenda of a meeting of high level officers, planned for 24 June, which listed in order of priority the projects of anti-mine warfare which should receive time and money for research and development.

A portion of the priority list follows:

(1) Mine watching and tracking of minelayers.

(2) "Sterile channel" - a channel which, through fixed influences, can be set up to make a whole area inhospitable to mines; for example, a strong magnetic influence, or a strong acoustic influence, which will either trigger a mine without blowing up a ship, or will "blind" it against ships' signatures.

Pollard indicated that setting off mines indiscriminately in harbors would be most undesirable if nuclear weapons were in use.

Lower priority general influence generators are pressure actuators and explosive destructors (MINT). A mobile technique for producing

strong influence at a distance from merchant ships is included in this category.

(3) Towed sweeps -- a product of a long term BuShips program.

(4) Mine location -- development of equipment.

(5) Navigation for mine countermeasures vessels.

(6) Mine destruction (including ahead-thrown weapons).

(7) Coastal Defense (Apparently concerning itself only with the administrative setup which will be required in the event of a defensive war.)

(8) Explosive Ordnance Disposal.

(9) Development of a general technique for mine hunting.

Among the last in priority are countermeasures against specific triggers and modification of ships' signatures -- except in the direction of making the latter strong enough to acutate distant mines.

The conclusion seems to be that the Navy is looking for new ideas in the field of mine warfare, and that all that is needed from us are the ideas.

Two or three radical suggestions, by John Isaacs of the MAC were offered by L.W. McKeehan for consideration:

In the Castle tests in the Pacific one result of the explosion of a nuclear bomb was the formation of pools of sediment on the bottom in shallow waters which were for some time thereafter sonar blanks. This may indicate that it is unwise to blow up mines in areas which will require further sonar search.

Patterson pointed out that similar sonar disturbances have long been known.

A technique used in land mining may be applied to harbor mining, which is to trigger two explosive units, placed some distance apart, simultaneously. This would discourage sweeping by introducing the probability that the sweeper will explode the second unit under itself, and makes mine watching the more attractive in that knowledge of the position of the entry point and local conditions would delimit the safe area around the mine.

Most of the thinking in defense against mines has concerned itself with preventing the preliminaries -- manufacture, delivery and triggering. It might be possible to counter the final and most significant effect of a mine -- its explosion. The explosion consists of two parts, the shock wave and the later bubble heave which does the damage by causing plate deformation and, in some cases, actually breaking the ship's back by bending the keel. One counter to this would be the installation of a computer which would analyze the shock wave and start a counter explosion throughout the length of the ship, lifting it out of the water bodily.

There is sufficient time for this, as the bubble heave comes several millisecond after the burst, and an explosion can be propagated the length of a ship at 30,000 feet/second or faster. Such a lifting of the whole ship by a self-actuated explosion will cause no damage if the propulsive machinery and personnel are protected with, in the first case, shock mounts and, in the second case, such simple attachments as thick rubber soles. L.W. McKeehan has himself been in such an explosion and can thus report from personal experience.

Other methods of isolating the ship from the surrounding water would include the formation of a blanket of bubbles around the hull, about one bubble layer thick. This reduces the acoustic signature but might have the disadvantage of reducing the propulsive efficiency to an undesirable extent. However, this would be tolerated for the period of traversing dangerous waters at low speed. The production of bubbles has already been used to shield propellers, and reduces propeller noise by up to 30 decibels. It is possible that a bubble layer would reduce the ship's pressure signature and send it aft. Unfortunately, such a bubble layer would probably not be effective against bubble heave; but it is possible that energy absorbing material placed on the bottom in important area of a harbor (empty oil cans for example) would materially reduce the effect of the heave at the surface.

In discussion, Hutchinson asked if it had been conclusively demonstrated that small cheap simulators of ships'

signatures could not be manufactured, provided engineering talent were thoroughly applied to the problem. Elliott referred to a computation by Nierenberg, reported at a recent meeting, which showed that pressure signature equal to one inch of water involves the transport of 5×10^5 cubic feet of water per minute. It was pointed out that even if such sweeping were made feasible, ship counting, delayed arming and combined signal triggers reduce its useful effectiveness to an extent that makes it nearly impossible to clear a channel with confidence.

There was some further discussion of the use of unsinkable "guinea pig" vessels for sweeping; but with the possibility of building in directional counting mechanisms, it was pointed out that the guinea pigs ought all to run one way, creating a jam at one end or the other in the supply line.

McKeehan concluded by reporting that the Inshore Survey Program first recommended by the MAC is now under reconsideration by CNO, the Hydrographic Office, and the MAC, and will be discussed at Woods Hole next week.

The afternoon session was devoted to the problems of underwater detection by acoustic and electromagnetic means.

W.W. Watson began by reporting on the Ninth Symposium on Underwater Sound held the previous week in Washington, and attended by him and Elliott.

It was attended by about 400 people and consisted of two full days of papers, from which it can be deduced that there is a great deal of time and money being spent in investigation of this field. There were many purely theoretical papers, whose applications to the field of mine or submarine warfare were not made clear, since the meeting was classified Confidential only. Of interest to us particularly is the work being done at tne University of Texas on a statistical analysis of the probability of detecting mines by sonar. Thoir experiments at Panama City under as nearly ideal conditions as possible (i.e., a previously cleared-by-hand sandy bottom) indicated a probability of 65% detection in a sweep, when no previous delimitation of the mined area had been made. The figure is the average attained after some 200 more runs. NEL reported on its correlation technique as applied to long range detection, and there was work reported in the use of sonar by underwater swimmers.

S.D. Elliott then gave the substance of the paper by A. Patterson, Jr. and himself presented at this meeting.

Elliott reported on the work done at Beavertail last summer, in which it was found that mine splashes can be listened to at some distance by submerged hydrophones, but that there is considerable doubt as to whether they can be distinguished, in the audio-frequency region, at least, from other sounds which may occur in a harbor or channels. However, of great interest

for absolute indentification is the low frequency pattern which followed all drops within a few seconds, and was not found in simple explosions. Mines dropped from a little below the surface produce the same effect, and it is deduced that this results from the mine actually hitting the bottom. More experimentation is planned with better low frequency listening devices to confirm this deduction. This phenomenon should be valuable in that passive listening techniques need not then be confined to air laid mines, but will serve to detect these laid from surface and subsurface sneak craft.

In the ensuing discussion, the point was discussed whether ESL should confine its experimental investigations to this one point in the field of underwater acoustics, but should study the work of others in order to recommend an intelligently-conceived system. For example, if, after a study of the possibilities of LOFAR, we should find that its probability of detection at long ranges is low, we should be prepared to recommend another detection system to back it up. In order to evaluate LOFAR, it would be advisable to find out what types of sounds Russian submarines do indeed produce. It may be that this system of detection will prove its worth if only in that it will force submarines to proceed so slowly as to permit detection by other means.

Members present asked to be informed concerning low frequency

sound propagation in water. Patterson stated that the British have been studying propagation at 10, 20 and 30 cycles and that their conclusion is that observed intensities were not in good agreement with theory due to the limited knowledge of under-bottom topography and defects in the theory of propagation. Above 10 kc, a great deal is known. However, there is a lot of room for study of the propagation of sound in shallow water, specific recommendations on this project having been made in a recent appointed group meeting in Washington.

A.A. Evett discussed electro-magnetic propagation in water; much of his material was obtained at the Underwater Electric Potential meeting held in Washington last December.

One experiment described consisted of attempts to pick up signatures of passing vessels by means of AgCl electrodes at 100-foot intervals on the bottom. These were able to detect submarines and obtained small signals from small surface craft. However, there were no detectable signatures from midget submarines. Pollard pointed out that the necessary AC amplifiers alone would cost about 1500 dollars per electrode. A careful economic study of the cost versus performance would be required, for comparison with more conventional methods of detection. NCL has been measuring the magnetic field of submarines with the idea of using this as a method of detection from shore station. However, most areas of interest produce so much background from power lines and

industrial installations that this is not feasible. There has also been investigation of the DC electric potential in ships, which is found to be equivalent to a dipole about 3/4 the length of the vessel. Currents of the order of amperes are produced by ships at rest, which fall off with ship age, indicating that galvanic action is responsible. A method of identifying submarines which have been detected by sonar by towing an array of electrodes from a helicopter has been proposed and tested. It is probable that the potentials induced by the motion of the electrodes would be higher than the expected signals, and that the maximum range of this method would be about 200 feet. The ASQ-8 detector has a range of up to 800 feet.

Dr. Hageman reported at that meeting that the maximum range of detecting mines by UEP is 10 yards, but that this could be extended by towing an array a few feet off the bottom using multiple units and achieving a sweep width of about 100 feet. The British have reached the same conclusions as we have in subproject Arlington: that feeding current into the water and then moving detectors is so little promising that they have not spent much time or money or produced much hardware.

There were two theoretical papers on the propagation of communications frequencies underwater, in connection with sub-to-air coordination. With correctly designed antennae, it would be possible to communicate over 100 kilometers from one sub to another at 100 kilocycles, if neither were submerged to too great a depth.

This range increases in sub-to-aircraft communication, since the major portion of the path is on the surface.

> The morning's discussion was entitled Fission, Fusion and Total War and was begun by F. Hutchinson. The importance of this topic lies in the fact that atomic weapons open up a new target -- the whole harbor.

Hutchinson began with a short description of the types of atomic weapons which have been made in the U.S. The simplest type depends for triggering on blasting two pieces of material into each other to attain critical mass. This weapon can be placed in a cylinder about 11" in diameter and is limited to about 20-kiloton yield. There is the implosion weapon, a sphere 31" in radius with high explosive lenses on its periphery. This will yield from 200 to 400 kilotons. The third is the H-bomb, the megaton weapon, whose packagability, dimensions, and deliverability are still in doubt. There is no doubt, however, that the Russians know about as much as we do concerning these three weapons and have them available. Their cost is cheap -- how cheap is top secret, but somewhere on the order of the cost of a bomber. Delivery of any of these weapons is cheaper than that of any comparable amount of destructive power in conventional weapons, because of the small quantity of personnel and equipment committed.

On explosion of an atomic weapon above ground, a fireball is formed with a surface temperature on the order of that of the sun. The shock wave sent out from the explosion may be regulated in range

and destructive power by the height at which the weapon is exploded. Radiation is produced, but this is considered insignificant, since only those areas destroyed by the shock wave or thermal radiation are affected. Fission products are carried up with the fireball and may remain at very high altitude for several days before dropping out in small concentrations. Radiation effects are something else again when the bomb is exploded under water or in the ground. In these conditions vaporized water or earth are carried up with the fireball for 60-to 100,000 feet, where they rapidly condense, probably using the fissions products' nuclei. Then they fall out, at a distance from point zero dependent on the winds, carrying lethal fission products with them. The distance of fallout was indicated by Naval Radiological Defense Laboratory personnel, when one of them said that with proper wind conditions a bomb exploded in New York could kill all the people in Philadelphia and Wilmington with its radiation fallout.

Most unfortunately for the understanding of this threat by the people of the U.S. this radiation effect was at first missed by the scientists at Bikini because the original measurements neglected the effect of runoff. The importance of run-off was only recently discovered, and was confirmed just last March; it is still classified as Secret, though it is pretty certain that the Russians know about it, having exploded almost all their bombs under so-called contaminating conditions. The

British, in their Montebello test, exploded the bomb in the hold of a ship 20 feet under the surface, and the few data which have come over confirm these latest discoveries.

It was suggested by Margenau that a bomb could be exploded at sea off a harbor, giving the population a few hours to evacuate, depending on the wind force. (At Bikini the fallout travelled about 130 miles in five hours) The radiation level would then render the harbor unusable for as much as a year.

W. Rall put on the black board a table of damage to be expected from the three types of nuclear weapons described above (p. 29). He pointed out from this table that the radiation effects are by far the most extensive, influencing, presumably, President Eisenhower's recent statement that there would not be another D-day. In atomic war, the friendly troops could not enter the contaminated area. It also influences the choice of weapons used to clear a beachhead of mines. Though a 20 KT bomb exploded underwater would clear all the mines within a half mile, the remaining radiation would prevent use of the beach for several months. If there were some way of achieving the explosive effect without the accompanying fission products, atomic weapons might be useful tactically.

There were questions concerning the best way of destroying an atomic mine. Could it be exploded so as to blow the essential elements apart instead of into each other?

E.C. Pollard discussed the method of delivery of atomic bombs.

The one presently available to the Russians is to send over one-way bombers. They could right now deliver between 50 and 200 bombs over the U.S. in one raid. It is this threat that Project Lincoln has been studying, and they estimate that, using radar and guided missiles (possibly with small atomic warheads) we could achieve an attrition of such an attack by 60%.

In about a year, a new threat will be available to the enemy - a concerted attack could be launched from aircraft and submarines, using missiles of the V-1 type. Once these missiles are launched they are very hard to stop -- our best bet is to intercept the carriers. It is in this phase that the long range detection of submarines becomes most important.

By about 1960, the intercontinental missiles of the type of the V-2 rocket will have been developed. Though stopping these would be extremely difficult (no feasible plan has as yet been advanced) it would not be impossible, for several reasons: after firing they are essentially out of control, follow a ballistic trajectory which can be computed, and they must go very high to achieve the necessary distance. It would be a little like intercepting a shell in flight, but not entirely impossible.

TABLE OF DAMAGE FROM ATOMIC WEAPONS

All radii in miles

	Damage				Thermal			Radiation[1.]	
Type of weapon	Complete	Severe	Moderate	Partial	Light	Structures	Personnel	*	**
20 Kiloton	.5	1	1.6	2	8	.75	1.5	.75	.33
80 Kiloton	.8	1.6	2.6	3.2	12.6	1.5	3	2	.75
5 megaton	3.2	6.4	10	13	50	7	13	12	4

* personnel able to withstand radiation during a single 8-hour day after two weeks

** personnel able to withstand radiation a single 8-hour day after two months

1. Radiation damage figures are for a contaminating blast only. For such a blast all other damage figures should be divided by two.

The material discussed on the afternoon of June 22 was largely a report on the ideas developed as a result of the Beavertail activity and all falls within the region of what might be called "last ditch" defense -- after the attacker has penetrated to the harbor area and has disposed of his mines.

W. Guild spoke first on the methods of limiting the area to be searched and cleaned up. These would be useful probably only in limited warfare and have been recommended because neither sweeping nor attempted location of mines whose approximate position is not previously known is sufficiently profitable to be employed.

The methods for locating the point at which mines have been laid were listed, together with their advantages and limitations.

1. Visual mine watching is limited to daylight or conditions of good visibility, including moonlight, under favorable circumstances, and is only effective in the case of air-laid mines. Under these circumstances it is quite reliable and can locate splashes at a range of up to two miles to within 100 or 200 yards. Since only a very few simultaneous splashes can be observed without confusion, a practical enemy countermeasure would involve dropping a large number of mines or decoys at once. The system is useful for direction of the countermeasures vessel to the splash point. It should work satisfactorily and would probably be necessary in limited regions not covered by splash-spotting radar, such as narrow channels, turning basins and dock areas.

2. Splash-spotting radar employs conventional equipment in modified form, and yields accuracies of 100 to 200 yards at ranges up to 20 miles. It is useful only in the case of air-laid mines and does not function well under conditions of heavy rain or high sea clutter. Large numbers of simultaneous drops may be recorded. Countermeasures, in addition to those commonly used against radar, might involve the production of small explosions in the water to simulate splashes, or guided missile which would home on the radar beam. Such a radar installation would be useful for direction of the mine countermeasures vessel, and for general harbor surveillance.

3. A range-only radar with moving target indicator (MTI), circuitry has a range similar to that of the preceding, and is likewise only useful in the case of the air-laid mines. Its accuracy and reliability should be somewhat better, since it measures range only, and the effects of sea clutter are substantially reduced. Similar countermeasures might be employed effectively, but rapid switching among several stations would confuse a homing missile. This apparatus would not be serviceable for subsequent navigation of the countermeasures vessel.

In discussion, it was suggested by Mr. McKeehan that this device be called the Fluctuating Target Indicator as being more precisely indicative of the way it works on mine splashes. There was some discussion of simulating splashes -- is the splash from a Russian mine sufficiently distinctive

to make it hard to simulate? This was felt to be the Russians' problem, not ours.

4. Tracking aircraft would indicate their path over about 200 yards width. Even if splashes were not seen, this limitation of the area to be cleaned up would be useful. Project Lincoln can provide this information, which could be recorded and stored in the Harbor Defense command post. It was here pointed out that the present defense doctrine indicates that the Harbor Defense Commander will be one and the same as the general area of defense commander, so that interchange of information of this type will be simply achieved. The means for radar tracking have been specified and will be maintained for total defense and can probably be considered reliable, but the radars can be jammed.

5. Tracking submarines is a harder and less well studied area. Several accustic methods, none of them foolproof, have already been discussed. For immediate harbor defense, the loop systems using the improved Canadian cable or the sonar fence with upward pinging transducers might be useful.

6. Passive listening with hydrophones connected by cable to the shore as tested at Beavertail indicated that this system can detect not only the surface splash, but also the arrival of the mine at the bottom, and is not limited, therefore, to air-laid mines. The arrival of a mine can by this means be detected at ranges exceeding 3,000 yards, and a array of hydrophones can locate the mine to an accuracy of about 100 yards. Laying of

cable is expensive, and its maintenance a continuous matter; hence the use of such an installation would probably be limited to sensitive inshore areas.

7. Another methods of listening would employ small self-contained instruments which would report by transmitting acoustic signals the occurrence of any noise-making event in their vicinity. A vessel regularly patrolling the harbor will listen for the signals and report the area in which activity has occurred. The accuracy of location of mines by these devices will be limited by their range and spacing -- indication of activity in the listening area of any one of these still leaves a large area to be searched. However, since these will probably be used in the outer reaches of the harbor where alternate channels are readily available, merely rerouting traffic may sufficiently take care of immediate danger to shipping.

8. Intelligent study of a harbor before an attack will do much to limit the clean up area. For example, in the Golden Gate, tidal currents are so strong as to remove any mine laid in that area.

J.K. Major began the discussion of proposed methods of locating and dealing with mines after the approximate location of their entry.

Major stated that location is not under consideration with atomic weapons, only with conventional types of which the Russians have an estimated 7×10^5 units available. In discussion it had been pointed out that R. Beringer's study of air-laid mines indicated

that 50% of the resting positions on the bottom were within 25' of the entry point, and 88% within 50'; therefore, the first step in mine countermeasures is to take the boat as near as possible to the entry point as determined by spotting. Then the short and medium range locators are employed to determine the mine's positions more accurately, and lastly, the mine is neutralized or destroyed. It is probable that there will be no new types of firing mechanisms to counter, as the present ones in combination are sufficiently complicated to make their sweeping impossible.

V. Withington described the success of the methods of navigation used at Beavertail.

Guidance by radio from shore using the radar or visual sighting instruments as reference gave excellent results. This success was due to the fact that the helmsman was not told where he was, but rather how to get to the desired location. The requirement for the rate of transmission and interception of this type of information has already been discovered in aircraft; the time factor required for a 600 knot jet aircraft to reach a destination within ten miles is precisely that of a boat maneuvering at two knots trying to reach a destination within 200 feet.

Since the combination of a good compass and radio control with the helmsman directly hearing the speaker is so staisfactory, our recommendation will be that no other navigation equipment be added to the countermeasures boat unless it conforms to the following stringent requirements; giving accuracy to 30 feet over a

range of 40 miles; affording means for the helmsman to steer to his destination; providing a track ashore for recording the inspected areas; and being capable of handling unlimited traffic. Radar can meanwhile be used not only for mine countermeasures, but also for the guidance of other craft using the harbor -- a system very comparable to the Ground Controlled Approach and traffic control used at airports.

F. Hutchinson suggested that a short range local navigation system could be provided by suitable designed buoys, laid on signal from shore as the boat reaches the observed splash position. From the buoy, which in its least complicated form will probably incorporate only a triplane, the boat can maneuver by sonar indication and search the area thoroughly. This requires good seamanship. The use of a small optical range finder was suggested, but for such a maneuvering problem it would probably be too complicated. Such a buoy can be designed with a simple underwater direction-indicating mechanism which could also be used by swimmers. At present swimmers are being directed by sonar, but the swimmer-sonar-voice method stands a very good chance of setting off a mine. Lights of high intensity were here suggested, and means of increasing their underwater range were discussed. Illumination was admitted to be difficult because of the scattering effect of suspended particles, but lights could be used as beacons to determine position, being presumably in themselves visible from a somewhat greater distance. Two or more buoys so

equipped could define an area for swimmers to cover. Suggested methods of increasing the underwater transmission of light include polarization, selection of the portion of the spectrum normally transmitted furthest in water, use of high intensity underwater flares, or pulsing of very high intensity light to increase its effective life.

Hutchinson also described the Mk 2 Ordnance Locator, a detector of only 30 foot range, which is used to supplement sonar in areas where the latter is not effective. This mechanism of very simple, rugged design detects mines with steel cases by detecting the difference in the earth's magnetic field caused by their presence. Unfortunately because of its short range, it must be towed very near the bottom; it is capable of setting off magnetically actuated mines, and it is not capable of detecting mines with non-magnetic cases. Other magnetic detectors were discussed.

W. Rall explained that no progress has been made on Underwater TV since last summer's work at Beavertail. Ranges up to ten feet have been attained in clear water under conditions of good illumination. In daylight at harbor depths artificial illumination is not needed. The worst defect is the fact that the present apparatus is very difficult to maneuver and place in the desired location. Visits to be made later during the week to USN/USL and Washington may establish the fact that underwater vehicles now under development can serve this purpose.

Evening Meeting

E.C. Pollard conducted this meeting, which was largely taken up with consideration of anti-submarine measures.

The best defense against submarines is attack against the submarine pens and supply depots. Every effort should be made to get Intelligence to obtain data in enemy harbors with a view to learning immediately when enemy submarines are located with nuclear weapons.

What sources of knowledge have we concerning secret enemy submarine movements, either through intelligence or from a listening apparatus such as LOFAR? It is obvious from present reports about the difficulties of detecting French and British submarines by LOFAR that we need information concerning the signatures produced by Russian submarines.

Dr. Margenau suggested a check with Rand, ORO and other operations research groups concerning their present evaluation of our vulnerability, primarily, of course, in harbor areas, and of the likelihood of nuclear bombing of particular harbors.

Complete defense offshore will involve an overlap of instruments and agencies. For example, if the Navy's ASW patrols are adequate, without modification of components, for the defense of the continental United States, will such an airborne anit-submarine patrol unnecessarily overlap the functions of LOFAR?

A potential defense is a sonobuoy with a 20 mile range, arrays of these to form an automatic sonar detection net in conjunction with centers for maintenance and computation (possibly the Texas Towers planned for Project Lincoln). It was pointed out that since such buoys do not yet exist, surface vessels properly equipped could maintain a constant listening patrol, reporting to a coordinating center. A properly constituted center of this sort would be charged with defense against surface craft and low flying aircraft as well as submarines.

It was recommended that an inter-agency conference be set up to discuss coordination of all types of Atlantic patrol.

A total system of anti-submarine defense was outlined as follows:

1. Intelligence concerning submarine movements.
2. LOFAR, Texas Towers, sonar and radar-equipped p'ckets.
3. But here is a gap; from fifty miles offshore to the harbor entrances we are undefended. This area requires more discussion and research. Perhaps the British CORSAIR (passive listening with correlation techniques) would be applicable in these waters, or LORAD in these waters, or LORAD in the Pacific (where the 2,000 fathom line approaches closer to shore). Aircraft will not be able to keep an eye on submarines in this region. L.W. McKeehan suggested the setting up of a series of

listening post fences across the northern end of the continental shelf off Nova Scotia and sowing the shelf with anti-submarine mines. Another suggestion was the use of correlation echo-ranging techniques, matters now being worked on at NEL.

It would seem that detection in this region, so far neglected might be a very good study for ESL. NEL has already suggested that we study the economics of their short range correlation echo work. Aerial detection of temperature differences between a submarine's wake and the surrounding water might be practicable in this area. So might magnetic detection. The idea, discussed recently with Burbank of NEL, of using Mk 6 mine cases equipped as simple sono-radio buoys might well have useful application here.

4. Last-gasp detection includes many techniques used in World War II harbor defense; magnetic loops (recently improved), nets, hydrophones, controlled mines, and the more recent short-range upward-pinging sonar fence.

5. The few remaining submarines are now assumed to have reached the harbor and begun laying mines. The bottom positions of these mines can be detected by cabled hydrophones or sono-sono buoys.

A similar total system for defense of harbors against air

attack was outlined:

1. Intelligence and
2. Long range detection have been studied by other laboratories and a system has been set up under the Air Defense Command. As enemy aircraft break through to the Continental shelf area.
3. Coastal Defense should receive information as to their tracks from ADC.
4. In the 0-50 mile zone offshore the aircraft are tracked by radars of types already in existance. Ultimately, a part of this tracking could be handled by the radars which are also designed for splash spotting.
5. Aircraft which have penetrated all previous defenses now drop mines in the harbor area. These are located on entry into the water by one of three means: Visual spotting, radar watching, or passive listening.
6. The process of locating and neutralizing mines common to both methods of delivery had been discussed during the afternoon. Pollard was optimistic about the possibility of opening the harbor before cleanup by causing ships to navigate around the known positions of mines. Captain Dench, on the other hand, described the extreme difficulty of maneuvering large vessels with the necessary accuracy.

The first part of this morning's meeting was taken up with a discussion of the pressure-sensing mine trigger for which as yet no simulated sweeping device has been developed.

C.T. Lane described various techniques which have been attempted, divided into two classes: "brute force" and deception. Under brute force, he listed towing a vessel - not necessarily a ship - which produces a pressure signal similar to that of a ship. The requirement for this signature (later described in more detail by M. Wiedmann) is a reduced pressure of at least one inch of water, lasting for at least eight seconds. Production of this reduced pressure may also be achieved by producing a vortex (investigated at Beavertail), by producing long period waves, or by a bubble-making device. In all of these, the amount of energy expended for satisfactory results is of the same order as that necessary to drive the ship whose signature is being simulated.

Under the deception method, he included the development of a vertical jet (being worked on by the Cook Research Laboratories) which will produce a positive pressure at the bottom for a time long enough to stabilize the pressure-sensitive element of the mine, and then move on, leaving the mine to think that a ship is passing and to explode aft of the jet-producing device and its containing vessel. Designs of special hulls to produce very low pressure signatures are also being investigated. Mr. Lane contended that there has not been enough study of the pressure-sensitive element itself. It might be possible to break it by

rupturing its diaphragm on application of very high intensity low-frequency sound. Such sound mechanisms were studied in the twenties in connection with fog horns.

However, as was remarked in discussion, there seems to be no way to beat the problem of the requirement of large amounts of power output; furthermore, triggers of mines are likely to operate with a combination of stimuli, time delays, ship-counting, etc., so that investigation of a special sweep is not an economical way of attacking the problem.

There was a lively discussion of the possible methods of planting an underwater atomic bomb in a harbor. Lane and some others argued that the enemy might wish to insure that any explosion in a harbor would also reduce our force by several warships and their invaluable skilled personnel, and might therefore arm a nuclear mine with a ship-counting mechanism (directional, of course) to explode it when a large number of ships were known to be in the harbor. This was countered by pointing out that if the harbor is destroyed anyway, as it will be after a nuclear explosion, the ships are useless; the Japanese made the mistake at Pearl Harbor of not attacking the harbor installations - the loss of those ships sunk was nothing compared with what the loss of Pearl Harbor itself would have been. Therefore, the majority opinion was that any nuclear weapon deposited in a harbor

would either be exploded immediately upon delivery or, if laid before the commencement of hostilities, would be triggered by a simple time mechanism or by a saboteur ashore. Pre-war delivery of such a weapon by an innocent tramp steamer would be very simple, since the complete inspection of such craft would consume so many man-days as effectively to tie up the harbor. Pollard also pointed out the disquieting fact that within a few years such pre-war explosions will be the more effective in that so many nations will be equipped with nuclear weapons that it would be difficult to know upon whom to wreak retaliation.

Under the guidance of Mr. Pollard, there was a general pooling of ideas related to coastal defense. There was no effort to organize these ideas, as this discussion was intended to encourage group creative effort. The ideas as produced were listed as follows:

1. The desirability of a war game study to establish the relative ease of attacking a harbor. The Rand Corporation was suggested as a source for information as to organization of war games. L.W. McKeehan explained that most war games are played with factors whose values are known and accepted without the possibility of personal bias; our first effort should be to establish the relative worth of various defensive systems. However, such an inquiry of Rand would probably fall within our charter, though the actual study of total war would not.

2. As a corollary to the above, Margenau suggested forming a team of "Russians" to sabotage our ideas.

3. We should know a great deal more about the effects of a nuclear harbor explosion; there has been no such test made, and we should propose one with one of our number as an observer. We should also recommend that the British data from the Montebello test be made available as soon as possible when permitted by resolution of the presently pending Congressional action on international nuclear relations.

4. An inquiry was made as to the possibility of our finding mines which would be triggered by cosmic rays. Ships provide essentially a "hole" in the water, being more transparent to cosmic rays than the water they displace. Two objections were made to this possibility, and therefore to wasting time on such a study. First, our own Navy feels that the present triggers, acoustic, magnetic and pressure, with their various combinations, delays, etc. are so nearly invincible, that there is no need for new mechanisms. If the Russians can be assumed to have reached the same conclusion, there is no need for us to consider such weapons. Second, Ortel stated that unless there are good experimental data to show that the passage of a ship would invariably trigger a cosmic-ray actuated mine, the

presumption would be that rays are so few and so random that such triggering with certainty of getting a ship on each explosion is doubtful. Guild added that the present policy is not to spend time trying to sweep specialized mines anyway; a single countermeasure is desired to cope with all types.

5. There should be consideration given to defense from three types of attack, "conventional", limited atomic war on military targets only, or all out nuclear war.

6. Major asked whether we have sufficient intelligence concerning the probable nature of Russian weapons in the event of an immediate conflict. Those mines of which Russia has such a large stockpile, according to the information of L.W. McKeehan, are steel-cased parachute-type mines, similar to our Mk 25 mines, capable of being fitted with various triggers.

7. Present underwater lighting apparatus is agreed to be highly unsatisfactory. Whether we choose to use TV or divers, the provision of suitable lights is important, both for illumination and for underwater navigation. The problem of illumination is similar to that in fog, the light scattered by suspended particles is partially polarized; hence polarization, or simply relocation of the lamp to provide transverse illumination on the area studied, would be an improvement. There was some discussion of the use of gated or

pulsed light, not for ranging, but to lengthen the life of a very high intensity light source. Phyrotechnic flares might also improve visibility, if only to delineate areas to be searched under water.

Pollard, in attacking the problem of evacuating harbor areas in the event of an atomic attack suggested that Rall's proposal for the provision of small cheap helicopters (of the type being developed on the West Coast) to every member of the population be considered. This provoked a prolonged and spirited discussion of such things as traffic problems.

9, 10, 11, and 12, suggested by various members, included the necessity for study of alternate harbors, beachheads, with the necessary shallow-draft beachable freighters, and whether the logistics of a nuclear war require the use of harbors at all. L.W. McKeehan pointed out that we should face the fact that after a large-scale nuclear explosion the likelihood is that the harbor will never be used again, at least for the remainder of the war.

13. There were some ideas along the line of creating sterile channels by means of chemistry or biology. Can we so influence underwater growth as to impede attacking submarines or damage mines? Can we, by liberal applications of such chemicals as calcium carbonate, clear up the water in a harbor so as to facilitate mine hunting by visual means?

Are there underwater organisms which, if encouraged, will provide illumination of their own, so that objects newly introduced into the environment will show up as shadows? There is a large area here in which we have no background of information; it was recommended that we seek such information from suitable people at Woods Hole. In connection with sterile channels, it was recommended that we think of scattering bubble-heave reducers, such as oil cans filled with air, in drydock and lock areas.

14. In connection with the necessity of clearing a beachhead of mines, it was asked if there were a possibility of making a non-contaminating nuclear weapon which would put mines over a large area out of action, but which would allow almost immediate subsequent occupancy by our troops?

15. There was no discussion of this last, but it was suggested that we should inform ourselves on bacterial and chemical warfare as it affects coastal defense.

The last afternoon of the conference was devoted to discussing recommendations concerning the future ESL program.

L.W. McKeehan read a proposed Study Group Analysis (attached in full). It was informally voted to take this under advisement, and to append such a report to a fuller account of the three days' discussion.

Patterson proposed that one of the major weaknesses of our defense -- the coordinating of all information concerning the presence of

enemy submarines -- be studied. He pointed out some of the difficulties in, for example, coordinating the information from two LOFAR sets. What type of data storage would be practicable in an overall coastal defense center? What types of computer and data presentation will lend themselves to use with the different types of information which may be available? How should such information be weighted?

W.W. Watson proposed a specific program to be followed during the coming year. First, and of immediate importance, is to gather together all information obtained in the past three years into a report on our proposed system for dealing with air-dropped mines. Secondly, a job well suited to a University would be a complete study of harbor dispersal, including the planning and use of beach-heads in lieu of harbors. Third, are the "hardware" jobs still remaining to be completed: the underwater acoustic study of the arrival of mines on the bottom, the M.T.I. radar study of splash characteristics and the influence of sea-clutter and rain or this type of radar, and possibly the equipping of an ideal counter-measures vessel in accordance with the recommendations of the boat study group. Fourth, ESL might well make a study of all equipment under development and report on a complete system for coastal defense. And lastly, there might be one or more limited studies performed in areas where we have unusual talent.

Pollard agreed with the foregoing, but wished to add further suggestions. It is important that the proceedings of this conference

be written up if it us to have any value, and he recommended a committee for performing this task. Next, an immediate beginning should be made in obtaining some of the information which was asked for in these discussions. He recommended organizing study group conferences with visiting lecturers from the Rand Corporation, from some group familiar with the organization of large quantities of diverse information, and two representatives of present day Navy operational mine warfare, one familiar with and practicing minesweeping, and one experienced in more complex countermeasures work including explosive ordnance disposal.

Pollard specifically confirmed Watson's opinion on the desirability of making a study of an entire system of coastal defense, and producing a report on our conclusions, though not necessarily in great detail. He reaffirmed his feeling that the major area in which too little thinking is being done is the region from 0 to 50 miles offshore. A group from ESL should be appointed to study the various methods of detection available with a view to making recommendations. Another group should be appointed to evaluate and follow up the various ideas proposed during the conference. And finally, we should learn all we can concerning the damage, to harbors in particular, which will be caused by a nuclear explosion, recommend tests where information is not available, and summarize our findings in a report.

Patterson then appraised our situation at the date of the conference. Before the end of the summer the report recommended by Watson and

long desired by Patterson should be completed. Material for this report runs back for the full three years of previous activity, and parts of it have been written piecemeal in the past. A major editorial effort will be required. As this report nears completion and personnel are gradually released from this pressing task, they can be assigned to the studies which will form our future program. Members present were reminded of thier specific responsibilities in the preparation of sections of this report; deadline dated were discussed.

Concurrently with the preparation of this report, experimental work will be done on radar mine splash target strength measurements at Ft. Nathan Hale in the New Haven harbor, and on a study of mine bottom-collision disturbances, using facilities in the Narragansett Bay area jointly with the Narragansett Marine Laboratory.

It was pointed out that the contract recently approved for the coming year includes a number of the items recommended by various conferees during the past three days for further study, while new undertakings not included would require negotiation with ONR Code 463, so that both ONR and ESL would have a mutual appreciation of the work in progress. Among the items for future work, the one which most directly ties in with our past program is the planning for a mine hunting boat, for its equipment and outfitting. There was further discussion of the desirability of having a consultant or contractor plan the general type of boat suited for this task, since there has been no attempt in the past to design a boat for

just such a purpose.

Patterson agreed that the 0-50 mile zone bounding the coastal area was a place where much thought and effort should be applied, and promised to review the findings of the low-frequency-shallow-water propagation committee to see if ESL could make a worthwhile contribution to this problem. The coordination of information gained on enemy movements in this area, as well as further out to sea was again emphasized as a problem for ESL action.

The conference was closed amid expressions of appreciation of the time and effort devoted by all to the endeavor.

CONFIDENTIAL ESL:150:pd
Ser. 010
15 Jun '54

ANNEX A

Tentative Program for ESL Conference June 21, 22, 23, 1954

It is intended that this conference examine the whole aspect of harbor protection for all kinds of warfare. One main purpose is to develop new ideas, rather than to go over old ground. For this reason the program outlined below is very tentative and represents only what can be discussed in the absence of any new material of greater interest. Any suggestions for changes will be welcome.

June 21 (Monday)
9:30 A.M.

Outline of conference purpose - E.C. Pollard or A. Patterson, depending on the latter.

(a) Inherent nature of problem - detection by intelligence, water transmission of sound, electromagnetic effects, visual observation of air and surface craft, radar observation of
(i) Submarines, aircraft, sneak craft, propelled mines.
(ii) Act of laying mines
(iii) Mine after being laid
(b) Action to handle harbor afterward in terms of
(i) Navigation around
(ii) Sweeping
(iii) Underwater swimmer de-arming or detonation
(c) Policy to recommend for harbor choice and design in view of the varied ways of rendering harbors useless.
(d) The specific nuclear weapon problem
(e) Approach of the conference. Need to look thoroughly at old ways of meeting (a) and (b) above and to look for new ways. Recap of history of the project.
(f) Outline of conference method

11:00 A.M. (After coffee break)
L.W. McKeehan - Sweeping - its successes and failures. Present day attitudes and equipment. Just how starry-eyed are we about trying to change Navy technique.

12:00 Noon Recess for lunch

1:30 P.M.
A. Patterson - The Water and how sound goes in it.
Applied broadly to long range and short range detection of anything in it.
Speakers and discussants to be arranged by A.P.

4:30 P.M. Recess
5:30 P.M. Cocktails for conferees
6:30 P.M. Dinner at some suitable locale.

June 22 (Tuesday)
9:00 A.M.
F. Hutchinson - Fission, Fusion and Total War
Three hour discussion to be led by him.

12:00 Noon. Lunch

1:30 P.M.
W. Guild and J.K. Major - Means of narrowing the search for mines.
To include H.L. Schultz and M. Rosenblum.

7:30 P.M.
General Discussion - led by E.C. Pollard

June 23 (Wednesday)

9:00 A.M.
C.T. Lane and M.L. Wiedmann - Pressure Mines, why they are good and what can be done about them.

10:00 A.M.
Topics which have arisen.

1:30 P.M.
A proposed overall system

A. Patterson
W.W. Watson
E.C. Pollard

Outlined till 2:30 in 20 minute pieces and discussed.

3:00 P.M.
Proposed program of research for whole Navy.
Discussion leader to be announced.

4:00 P.M.
What part should ESL play in this?

5:00 P.M.
End conference

E.C. Pollard
Program Chairman

ANNEX B

ATTENDANCE AT ESL CONFERENCE - 21-23 June, 1954

L.W. McKeehan	H.L. Schultz
A. Patterson, Jr.	M.L. Wiedmann
E.C. Pollard	V. Withington
W.W. Watson	R.E. Barrett
W.R. Guild	A.A. Evett
F. Hutchinson	J.K. Major
C.H. Dench	W.C.G. Ortel
C.T. Lane	S.D. Elliott, Jr.
H. Margenau	M.J. Rosenblum
L. Onsager	M.E. Purdue
W. Rall	G.F. Pieper

ANNEX C .

CONTRACT NUMBER: Nonr-609(02) 1 May 1954

"Annex A (Revised)"

SECTION A: The Contractor shall furnish the necessary personnel and facilities for and, in accordance with any instructions issued by the Scientific Officer or his authorized representative, shall conduct research on specified problems in coastal defense and pertinent mine countermeasures. Said research shall include, but not necessarily be limited to, a study of protection of overseas shipping terminals by this nation along with coastal defense of continental United States. The Government will assist the Contractor in arranging field tests and experiments at Government laboratories and stations when necessary for most effective accomplishment of the task.

The primary objective of this Task Order is that the Contractor shall provide the services of the "Study Group" heretofore organized under Contract Nonr-609(02), to carry out study and analysis of problems in coastal defense chosen on the basis of importance and with concurrence of the Scientific Officer.

The secondary objective of this Task Order is the conducting of limited experimental research in coastal defense. Said experimental research will be directed toward solution of pertinent problems chosen by the Principal Investigator with the advice of the Study Group. Exploratory research leading to improved schemes of coastal defense shall be conducted. Support for each experimental task shall be within the limits approved in writing by the Scientific Officer.

The Study Group will serve as a central study and advisory group on specific coastal defense and countermeasures problems. Said services shall include, but not necessarily be limited to, the following:

(a) theoretical evaluation of ideas presented from other organizations through the Scientific Officer;

(b) comparative evaluation of foreign (principally the United Kingdom) and United States effort;

(c) specific recommendations and use of research and development results in coastal defense systems; and

(d) assistance to other Department of Defense agencies, laboratories and Contractors at the specific request of the Scientific Officer.

In addition to the above, said Study Group will:

(a) Work to ascertain practicable methods of integrating information from all sources to obtain knowledge of tracks of all potential mine-layers sufficient to permit timely counteraction. This will involve determining:

1. the information that can be made available or that is required for adequate solution of the problem and

2. a practicable method of collecting and using the information.

(b) Study the validity of methods used to estimate the extent and duration of harbor function disablement by nuclear weapon attack, seek the causes of any significant differences among estimates of potential damage, and recommend specific means for resolution of any inexplicable differences among such estimates.

(c) Study the most useful combination or combinations of equipments (e.g., sonar, underwater TV, navigation systems) for precise mine location and mine disposal, with effort focused on specifications for eventual outfitting and testing of the mine-hunting boat as a supplement or replacement for mine sweeping vessels.

The initial experimental program under the contract will include the following:

(a) Study and perform experimental measurements on characteristic sounds of mine water entry and mine impact on bottom to provide data for design of a practical acoustic mine watching and location system.

(b) Provide design data for a small, low-cost, self-contained device that will detect and signal the laying of mines in the immediate vicinity of the device.

(c) Develop electronic systems for a Moving Target Indicator radar to aid in display and recording of mine splashes in the presence of sea clutter and fixed targets.

SECRET

ANNEX D

ESL:150:pd
Serial 0028
23 June 1954

Study Group Analysis Proposal
L.W. McKeehan

23 June 1954

Study Group Analysis No.-

The Study Group has spent three days (21-23 June 1954) in considering problems of coastal defense in (1) limited, and (2) unlimited, warfare (as defined in S.G. Analysis No. 1) with the USSR and Satellites (including Communist China) by a coalition of the U.S.A. and currently probable allied or associated nations. It is realized that the unavailability to the S.G. of good information as to U.S.A. commitments and intentions in various circumstances leading to such warfare makes the S.G. conclusions less reliable than might be desirable, but these conclusions are so general that they are presented with some confidence.

The S.G. considered the possibility of an intermediate scale of warfare, in which only fission weapons would be used on targets of direct military significance, without concurrent or retaliatory use of fusion weapons against centers of population. It concludes that the probable duration of such half-unlimited warfare would be so short that it is unprofitable to consider a research and development program appropriate only thereto.

The S.G. concludes that the problems of mine countermeasures would be of low relative interest in unlimited warfare. A principal reason for this conclusion is the belief that in unlimited warfare the concentrations of fighting men and war material which justify

heavy oversea traffic in war would abruptly cease to be profitable.

The S.G. concludes that the need for defense of friendly areas at the greatest possible distance therefrom is equally necessary in both kinds of warfare and that this requires extensive U.S.A. preparations for long-range detection and tracking (as preliminary to long-range counter-attack) of possible mine-laying and bomb-dropping or missile-launching aircraft and of mine laying and torpedo-or-missile launching submarines. It is not considered that interest in these preparations is peculiar to coastal defense nor needs more attention under Contract Nonr-609(02) than that involved in making sure that the transition from long-range to short-range tracking is smooth and reasonably leak-proof. This transition should take place outside the twenty-five-fathom line, currently limiting the effectiveness of conventional unsweepable ground mines, or outside the range of guided missiles deliverable by submarines, whichever is farther out from harbors or beachheads of interest. (The S.G. considers that in unlimited warfare the operation of temporary beach-heads with good air cover and seaward defense would be mandatory, and sufficient, for residual logistic needs.)

The tightening of the defense against enemy intruders penetrating into coastal areas (from either the sea side or the continental side) needs active research and development leading to adequate tracking and spotting over and in channel and harbor waters, of possible mine-layers and of laid mines. Some of this research

and development is the business of Contract Nonr-609(02), and all of it is of direct interest to the S.G. therein. If atomic or thermo-nuclear weapons are identified in any such area (probably by their characteristic explosions) it is the opinion of the S.G. that neither mining nor mine countermeasures need be anticipated in that area for months thereafter.

The S.G. continues to have an interest in mine-sweeping which will always be necessary at least as a supplement to other mine countermeasures.

The S.G. believes there is further urgent need for active research and development on mine hunting vessels, their equipment, their navigational control and their techniques of operation; in order to expedite the marking and clearance of small areas (determined by tracking and spotting) in which the presence of latent or active mines is most probable and most restrictive. Such techniques must make possible close inspection and subsequent recovery and study of new mines and (possibly, but not probably) of fission or fusion weapons which have failed to function or which, as prelaid sleepers, mark an intended transition from limited to unlimited warfare. In this research and development Contract Nonr-609(02) should continue to cooperate.

The information required in the coastal area for local use in defense against mining comes from many sources. Its integration

and presentation for operational use present unsolved problems in which the S.G. sees tasks appropriate to its limitations. Some of these problems also require work not now in the known program of long range tracking.

Finally there is, in the opinion of the S.G., urgent need, in preparation for unlimited warfare, for better integration of coastal defense with civilian defense, and for improvement of both, in order to provide for quick transition from conventional harbor functions to beach head and alternate port use after large-area devastation. The evacuation of stevedores, in large numbers, and of key personnel required for cargo handling and distribution, both in and back of the harbor to the best new (or old but undamaged) places for resumption of their duties will be particularly essential. Diversion of released combatant and manufacturing manpower to unmechanized logistic functions will be appropriate. It is also considered by the S.G. that at the very least every important port should prepare two strong points capable of survival, to accommodate harbor control organization plus subsistence and a communication means, within the area that would otherwise to completely destroyed by a massive attack. The supply of two such "shelters" farther apart than the diameter of a large fusion weapon "crater", now seems logical. These might be considered as storage warehouses for key personnel, for information, and for decontamination gear during maximum radiation hazard.

RML:150:ed
Serial 0028
13 June 1956

The S.G. does not know of any adequate study of the type of problem dealt with in the last paragraph, and concludes that study of existing and proposed solutions of such problems is probably a proper part of the program authorized under Contract Nonr-609(02).

Specific recommendations with respect to new, or newly defined tasks under the Contract will follow.

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